Using Wind Streamlines
to forecast the onset of snow in Anchorage, AK
By Kristine Nelson

Introduction:
Precision and accuracy are expected of Center Weather Service Unit (CWSU) Meteorologists. While FAA Air Traffic Managers understand it can be difficult to accomplish these two at the same time, they need the Meteorologist to make their best forecast and update as necessary.

In Anchorage, one of the biggest impacts to Air Traffic and one of the most challenging forecast dilemmas, is snow timing and amounts. Anchorage CWSU Meteorologists have found wind streamlines to be a tremendous tool for picking out the subtle pattern features that can help narrow down the onset, duration, and dissipation of snow events. Snow amounts are still quite tricky to forecast, but since Air Traffic Managers are more concerned with reductions in ceilings and visibilities than the actual snowfall, timing is the CWSU Meteorologist's biggest focus.

Overview :
Complex Terrain can magnify precipitation intensity or protect Anchorage from moisture depending on the position of the storm low center and wind flow through and over the terrain. Sometimes easterly winds pass through Turnagain arm as a gap wind event or over the Chugach in a downslope/Chinook event and dry out Anchorage such that little or no moisture reaches the surface. Usually, the stronger the storm, the greater the downslope/gap wind, and the more likely conditions will remain dry in the Anchorage bowl. In many locations in the U.S., the big storms bring the biggest weather. In Anchorage, little storm systems with light winds and especially those with storm centers that track into Prince William Sound, tend to produce the greatest amounts of snow. Unfortunately, not all weak storms that track into Prince William Sound bring snow to Anchorage.

Once it is established that a weak low will move into Prince William sound, there are still many other variables that need to line up to bring Anchorage snow. Sometimes a weak storm moving through Prince William Sound brings no snow at all because the moisture never makes it into the Anchorage bowl. The temperatures may be perfect, but without moisture, there will be only cold, dry, and maybe windy conditions in Anchorage.

When looking for Anchorage snow, there are subtle clues to be mindful of: warm or cold air advection (depending on the scenario and existing weather conditions), moisture advection via light easterly winds through Turnagain Arm, the presence of instability and/or vorticity at 700mb and/or 500mb, weak "waves", "wiggles", "kinks", or convergence areas in the 700 mb flow, and/or the location of 925mb low. The more of

these elements that line up, the greater the amount of snow you can expect….usually. However, sometimes you can have all the right elements set up and have a general idea of when the snow will start, but you don't know what specific time to start everything.

Picking a time for snow onset in the TAF, Public Forecast product, and in the morning Center Weather Service Unit briefing to Air Traffic Managers can be difficult. Using wind streamlines can help magnify those weak wiggles and kinks in the 700mb and 925mb flow to make snow forecast onset and dissipation easier to spot. This paper will look at a particular case from Jan 09, 2008.

Case Study: Using Streamlines to determine the beginning of snow Jan 09th, 2008:
The mainland of Alaska was under one large 500mb trough. Embedded within that trough were three low pressure centers. One was in the Bering Sea and heading south, another was moving north along the coast of the Kenai Peninsula, and a third weak low was centered near Yakatat and connected to the low along the Kenai Peninsula.

The NAM showed a 700mb low (figures 1-2) moving north into Prince William Sound and a 500mb low vorticity maximum (figures 3-4) stretching from the west side of Cook Inlet into Prince William Sound tracking northward near the Anchorage Bowl area by 00z Jan 10th. The NAM also showed a brief 700mb low in southern Cook Inlet around 2100z, then it disappears by 00z Jan 10th. NAM surface forecast (figures 5-6) brought precipitation into Anchorage around 18z, then really increased precipitation amounts by 21z. Models also showed warm air advection at 850mb (figures 7-8) from 18z to 21z with temperatures moderating from -12C to -10C by 21z and light easterly winds through Turnagain Arm. However, there were no other model indications of the exact timing of snow onset. Would steady snow begin at 18z per the NAM precip guidance?

All meteorological indications pointed towards snow. The problem was timing. When would it start and how long would it last? What was the model seeing at 21z to increase the precip values that much? Was it the 700mb low in lower Cook Inlet that the models formed then dissipated? Or was it something else?

Streamlines can be used as a nowcasting tool to help pick up subtle features in the model derived wind flow to help with precipitation onset and dissipation. 700 mb streamlines overlaid with radar data (the order of loading these two parameters is key. If you load the radar first, you get all the radar images, but lose the ability to detect the movement of model derived features) can show a kink in the wind flow and radar echos that are connected to it. 925mb streamlines overlaid with model derived precip can show circulation patterns, low locations, and convergence zones.

In this particular case, there is a distinctive bend in the 700 mb streamlines that is connected to radar reflectivities in the 18z and 21z 700mb streamline and radar data set (figures 9-10). In addition, a 700mb Cook Inlet secondary circulation becomes more visible. 925mb streamlines (figures 11-13) showed a clear circulation and convergent area moving into the Anchorage area.

Anchorage surface observations (Table 1) showed that snow fell briefly at 18z, stopped, then became much more intense at 20z, which is about the time the wave depicted in the 700mb streamline model data and radar overlay was forecast to move over and the same time the 925mb streamline convergent band and circulation was forecast to reach Anchorage.

Summary:
Given the right set of pre-existing conditions for snow, 700mb wind streamlines, especially when overlaid with radar imagery, and 925mb streamlines can help Meteorologists pick out subtle – or not so subtle – changes in the model derived wind flow to help narrow down the timing of onset of snow.

Acknowledgements:
Thank you to James Nelson (SOO ANC WFO) for helping me use the WES to pull up AWIPS data and create the images and for editing this paper.

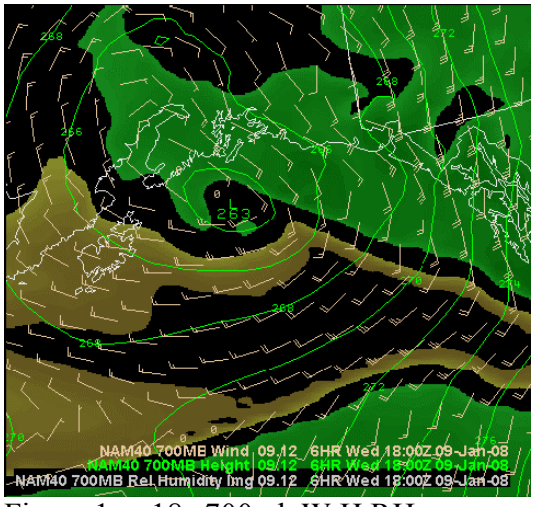


Figure 1….18z 700mb W,H,RH

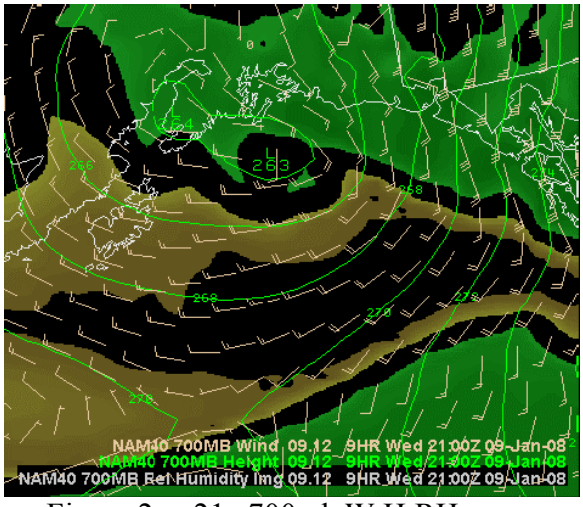
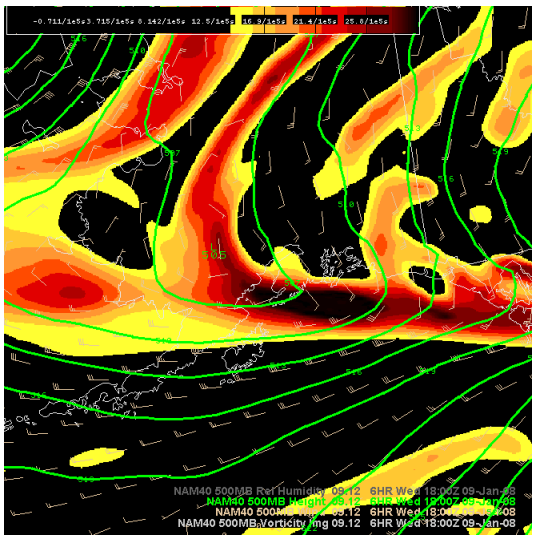


Figure 2….21z 700mb W,H,RH



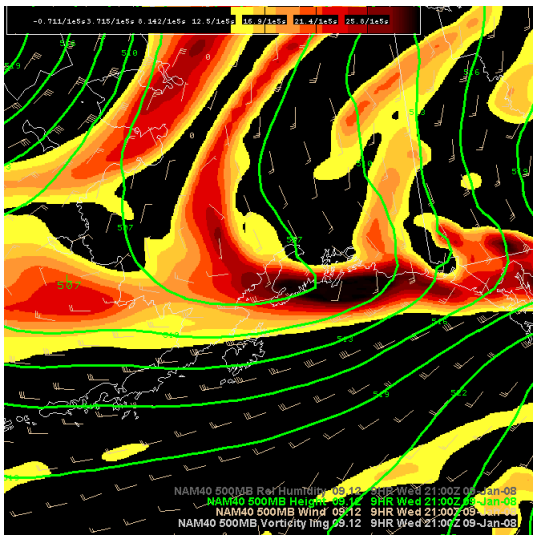


Figure 3….18z 500mb H,W,Vort image

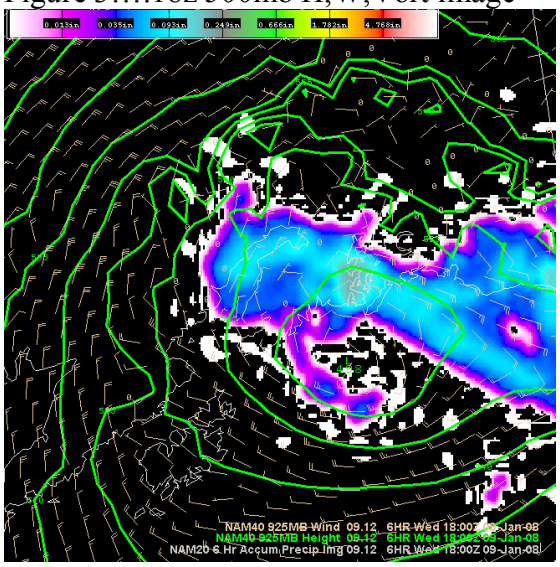


Figure 4…21z 500mb H,W, Vort image

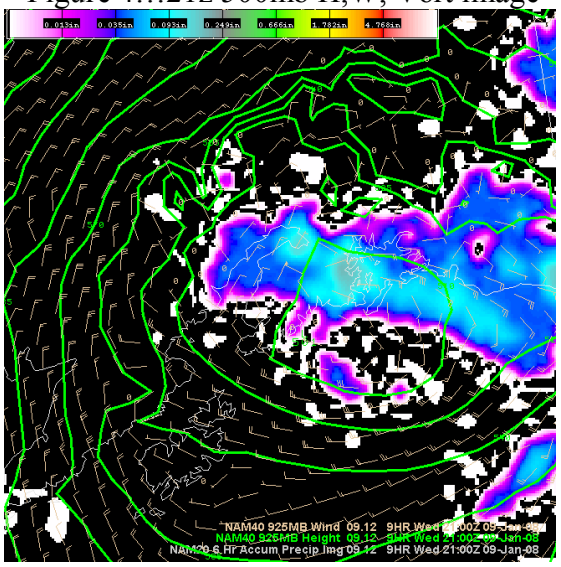


Figure 5..18z 850mb MSL,W, Precip image

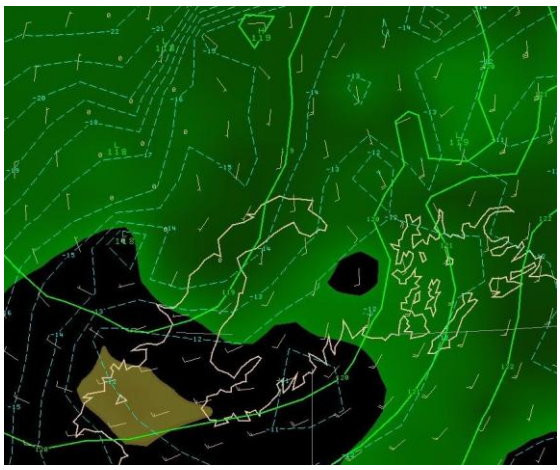


Figure 6..21z 850mb MSL,W, Precip image

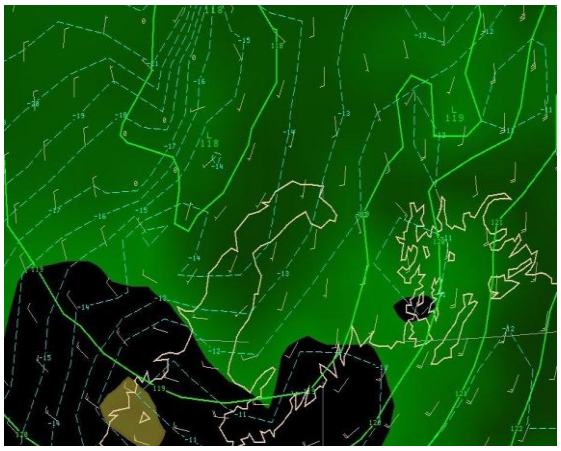


Figure 7….18z 700mb H,W, RH image

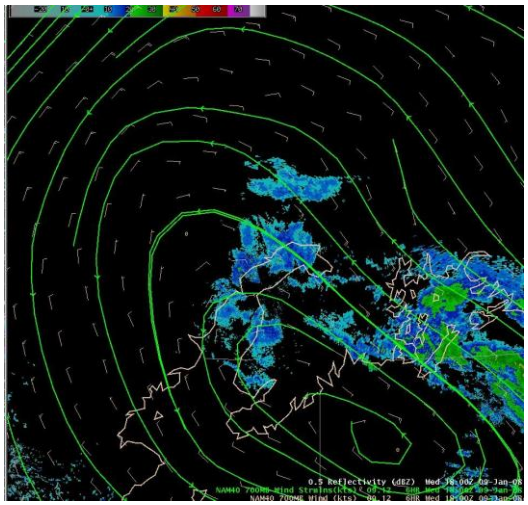


Figure 8…21z 700mb H,W, RH image

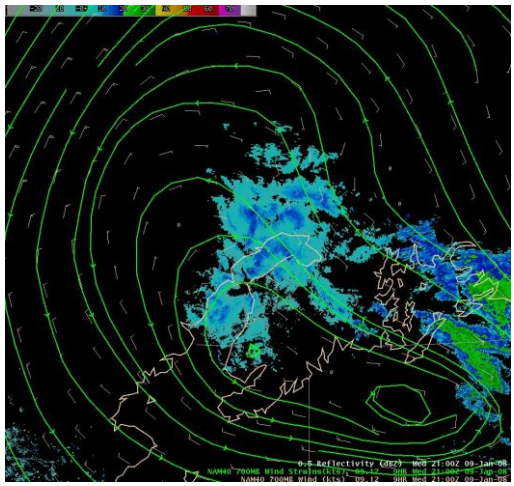


Figure 9…18z 700mb Strmlns, Radar, W

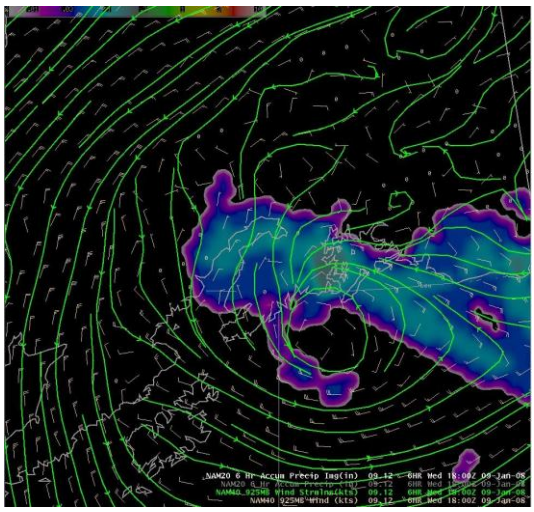


Figure 10…21z 700mb Strmlns, Radar, W

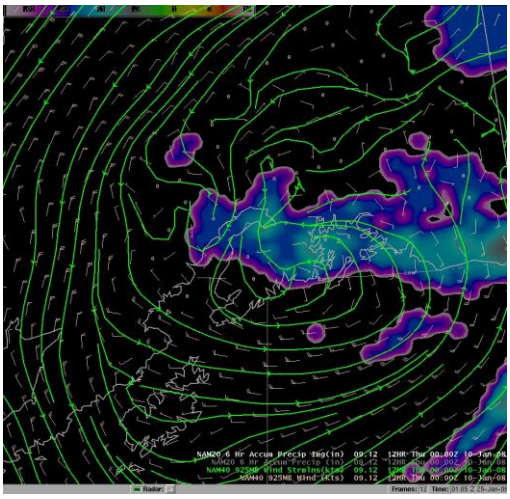


Figure 11..18z 925mb Strmlns, W, P image

Figure 12….21z 925mb Strmlns,W,P image

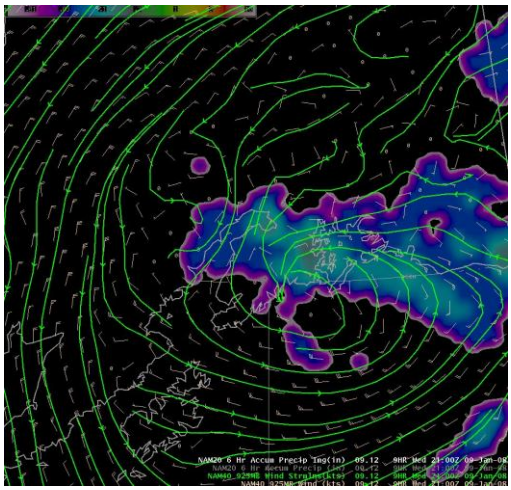


Figure 13…00z 925mb Strmlns, W, P image

Site	M/A	Day	Time	Sky Conditions	VIS	Weather	Temp	DP	Wind(kt)	Alt	RH	Chill	Peak
PANC	AA	9	1753Z	FEW009 BKN055 OVC070	10	S-	17	12	00000	917	80%	17	
PANC	AA	9	1853Z	FEW009 SCT070 OVC090	10		17	6	35005	919	61%	9	
PANC	AA	9	1953Z	FEW009 BKN038 BKN070	4	S-	16	7	00000	919	67%	16	
PANC	AA	9	2053Z	FEW022 BKN055 OVC070	7	S-	16	9	36005	919	73%	7	
PANC	AP	9	2136Z	BKN022 OVC042	2	S-	16	9	00000	919	73%	16	
PANC	AP	9	2140Z	VV010	1	S-	16	10	00000	919	77%	16	
PANC	AP	9	2144Z	VV008	3/4	S-	16	10	00000	919	77%	16	
PANC	AA	9	2153Z	VV008	3/4	S-	15	10	00000	919	80%	15	
PANC	AP	9	2238Z	VV012	1	S-	16	10	00000	920	77%	16	
PANC	AP	9	2248Z	VV008	3/4	S-	16	10	00000	920	77%	16	
PANC	AA	9	2253Z	VV005	1/2	S	16	11	00000	920	80%	16	

Table 1…ANC obs for Jan 9th, 2008